

Application Number: 10/517,674
Amendment Dated: June 4, 2007
Reply to Office Action Dated January 4, 2007

REMARKS

This amendment is responsive to the Office Action dated January 4, 2007 for which a three (3) month period of response was given. A Petition and fee for a two (2) month extension of time accompany this paper. No additional claim fees are believed to be due. However, should further extensions of time and/or additional claim fees be due, the Commissioner is hereby authorized to treat this paper as a Petition for any needed extension of time and to charge any fees due to Deposit Account No. 50-0959, Attorney Docket No. 089498.0439.

Claims 1, 3, 4 and 7 through 13 are pending in the present application upon entry of the amended claims shown above. Claims 1, 3, 4 and 7 through 13 have been amended for clarification purposes. Support for the amendments to claims 1, 3, 4 and 7 through 13 can be found in the specification as filed. As such, no new matter has been added.

Additionally, the specification has been amended. As will be explained in detail below, support for the amendments to the specification exist in either the priority document (United States Provisional Patent Application No. 60/385,527 filed June 4, 2002) or a NASA paper of such priority document, as published in April 2003.

In light of the above, no new matter has been added. Accordingly, entry and consideration of the above-mentioned amended claims set and amendments to the specification is believed due, and is respectfully requested.

I. Objections to the Specification:

The specification has been objected to in light of a partial equation on page 21, line 4 and an inadvertent typographical error on page 48, line 17.

Regarding Equation (39) on page 21, line 4, this Equation has been replaced based on the disclosure contained in the published NASA paper that was filed in view of the disclosure contained in the present application's priority document, United States Provisional Patent Application No. 60/385,527, filed June 4, 2002.

Application Number: 10/517,674
Amendment Dated: June 4, 2007
Reply to Office Action Dated January 4, 2007

As proof of the above, attached hereto is a printout from the NASA website of the biographic data for the afore-mentioned publication. As can be seen in the attachment, the paper in question was published in April 2003. Also attached hereto are pages 1, 5 and 10 of the April 2003 publication. As can be seen from page 10 of the published article, Equation (39) is correct as amended above. Given the disclosure contained in the present application as filed, and the afore-mentioned published article, one of ordinary skill in the art would recognize that original Equation (39) contained an inadvertent typographical error. In particular, the font size of the first portion of Equation (39) was inadvertently made too small to be legible at a normal view.

Given the above, and in light of the attached evidence, no new matter has been added in connection with the correction of Equation (39). As such, entry of the corrected version of Equation (39) is believed due and is respectfully requested.

In light of the above objection, Applicants' undersigned attorney undertook a review of the remaining equations in the specification as filed. In light of this review, it was determined that an inadvertent typographical error exists in Equation (8) as filed. This inadvertent error is similar to the inadvertent error of Equation (39). That is, a font size too small to be legible at a normal view.

In light of the above, original Equation (8) was replaced with an appropriately sized Equation (8) as is shown above. Given the afore-mentioned facts, and in light of the attached evidence, no new matter has been added in connection with the correction of Equation (8). As such, entry of the corrected version of Equation (8) is believed due and is respectfully requested.

Furthermore, regarding the inadvertent typographical error on page 48, line 17, this inadvertent typographical error has been corrected and the passage now reads "life of the cell."

Given the above, it is believed that the objections to the specification have been rendered moot in view of the corrections detailed above. As such, withdrawal of the afore-mentioned objections is believed due and is respectfully requested.

Application Number: 10/517,674
Amendment Dated: June 4, 2007
Reply to Office Action Dated January 4, 2007

II. Objection to Claim 12:

Claim 12 has been objected to due to an inadvertent typographical error. As such, claim 12 has been amended to read "the measured output". Given the amendment made to claim 12, the objection to claim 12 has been rendered moot. Accordingly, withdrawal of the objection to claim 12 is believed due and is respectfully requested.

III. The 35 U.S.C. §102(b) Rejection:

Claim 4 has been rejected under 35 U.S.C. §102(b) as lacking novelty over Yoon et al. (United States Patent No. 6,160,382). With regard to Yoon et al. this patent discloses a method and apparatus for determining characteristic parameters of a charge storage device based on a frequency range of impedance measurement and a non-linear equivalent circuit model.

Furthermore, the Examiner contends Yoon et al. discloses control means that use a separate voltage/current generator to charge the storage device directly, so that the voltage/current generator outputs a predetermined voltage and current thereby charging a charge storage device via the control means. Given the above, the Examiner contends that Yoon et al. discloses a plurality of states in an electrical storage device where such states are used to generate an estimated output signal so that a controller is able to mitigate any damage from occurring to such an electrical storage device. For at least this reason, the Examiner contends that claim 4 lacks novelty over Yoon et al. Applicants respectfully disagree.

As would be apparent to those of ordinary skill in the art, Yoon et al. clearly fails to disclose, teach or suggest an optimal recharging controller for an electrical storage device that comprises, among other components, an observer component which receives a correction signal and an input signal so as to generate an estimated output signal and an estimated internal state signal, wherein the correction signal represents a real-time estimate of the amount of damage being done to the electrical storage device during recharging.

Application Number: 10/517,674
Amendment Dated: June 4, 2007
Reply to Office Action Dated January 4, 2007

This is because, as would be apparent to one of ordinary skill in the art, the disclosure contained in Yoon et al. does not contain a nonlinear circuit model. Additionally, given the disclosure contained in Yoon et al., one of ordinary skill in the art would recognize that Yoon et al. presents no concrete evidence, or specific teaching, of a recharging controller that permits real-time damage estimates. This is because Yoon et al. contains no disclosure, teaching or suggestion a method by which to control a charge-discharge cycle in order to minimize battery damage during charging.

Since Yoon et al. fails to disclose, teach or suggest each and every aspect of the invention recited in amended claim 4, Yoon et al. fails to anticipate claim 4. As such, claim 4 is believed to be patentable over Yoon et al. Accordingly, withdrawal of the above-mentioned novelty rejection is believed due and is respectfully requested.

IV. The 35 U.S.C. §103(a) Rejections:

Claims 1 and 3 have been rejected under 35 U.S.C. §103(a) over Yoon et al. (United States Patent No. 6,160,382) in view of Yamamoto et al. (United States Patent No. 4,360,762). Regarding Yoon et al. the teachings and shortcomings thereof are detailed above.

Given the above, Yoon et al. clearly fails to disclose, teach or suggest a method for charging an electrical storage device so as to extend the life thereof, wherein the method comprises the step of deriving an instantaneous damage rate from measured voltage values.

Turning to Yamamoto et al., Yamamoto et al. discloses an improved starter switch for a fluorescent lamp. In particular, Yamamoto et al. relates to a starter switch which fires a fluorescent lamp very quickly. Given the disclosure contained therein, Yamamoto et al. fails to cure the deficiencies of Yoon et al.

This is because one of ordinary skill in the art would clearly recognize from the disclosure contained in Yamamoto et al. that Yamamoto et al. clearly fails to disclose, teach or suggest a recharging controller, or method of charging an electrical storage

Application Number: 10/517,674
Amendment Dated: June 4, 2007
Reply to Office Action Dated January 4, 2007

device, that utilizes a real-time damage sensor, or instantaneous damage rate, given that Yamamoto et al. is only concerned with a starter switch for a fluorescent lamp.

Thus, for at least the above reasons, claims 1 through 3 are patentable over the combination of Yoon et al. and Yamamoto et al. As such, withdrawal of the obviousness rejection of claims 1 and 3 is believed due and is respectfully requested.

Claims 7 through 13 have been rejected under 35 U.S.C. §103(a) over Yoon et al. (United States Patent No. 6,160,382) in view of Gartstein et al. (United States Patent No. 6,118,248). Regarding Yoon et al. the teachings and shortcomings thereof are detailed above.

Given the above, Yoon et al. clearly fails to disclose, teach or suggest a method for charging an electrical storage device so as to extend the life thereof, wherein the method comprises the step of deriving an instantaneous damage rate from measured voltage values.

Turning to Gartstein et al., Gartstein et al. discloses a rechargeable battery having a built-in controller that is designed to extend the service run time of the battery. In one embodiment, the controller of Gartstein et al. may extend the service run time of a rechargeable battery, for example, by ending the discharge cycle at the optimal discharge depth in order to maximize the number and efficiency of charge cycles. Given the above, the Examiner contends that Gartstein et al. cures the deficiencies of Yoon et al. and thus renders claims 7 through 13 obvious. Applicants respectfully disagree.

As would be apparent to one of ordinary skill in the art, upon reading and understanding Gartstein et al., Gartstein et al. fails to disclose, teach or suggest a recharging controller for an electrical storage device that comprises, among other components, an observer component which receives a correction signal and an input signal so as to generate an estimated output signal and an estimated internal state signal, wherein the correction signal represents a real-time estimate of the amount of damage being done to the electrical storage device during recharging.

Application Number: 10/517,674
Amendment Dated: June 4, 2007
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This is because, as would be recognized by one of ordinary skill in the art, Gartstein et al. minimizes damage to a battery by using a lowest cutoff voltage for discharging, or lowest state-of-charge. As such, one of ordinary skill in the art would recognize that the disclosure of Gartstein et al. does teach or suggest the optimization of the entire charge profile of a battery. Additionally, Gartstein et al. does not disclose, teach or suggest determining characteristic parameters, rather Gartstein et al. just estimates the state-of-charge.

For at least the above reasons, one of ordinary skill in the art would recognize that Gartstein et al. clearly fails to disclose, teach or suggest an instantaneous damage rate sensor, or real-time damage estimates. Given this, Gartstein et al. cannot control the charging or discharging profile of a battery in the manner accomplished by the presently claimed invention as recited in pending claims 7 through 13.

Thus, for at least the above reasons, claims 7 through 13 are patentable over the combination of Yoon et al. and Gartstein et al. As such, withdrawal of the obviousness rejection of claims 7 and 13 is believed due and is respectfully requested.

V. Conclusion:

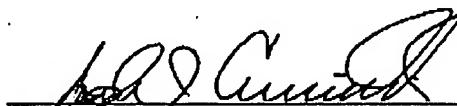
Accordingly, reconsideration and withdrawal of the pending objections and art rejections of claims 1, 3, 4 and 7 through 13 is respectfully requested.

For at least the foregoing reasons, the present application is believed to be in condition for allowance, and a Notice of Allowance is respectfully requested.

Application Number: 10/517,674
Amendment Dated: June 4, 2007
Reply to Office Action Dated January 4, 2007

Should the Examiner wish to discuss any of the foregoing in more detail, the undersigned attorney would welcome a telephone call.

Respectfully submitted,



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Title: Optimal Battery Charging for Damage Mitigation
Author(s): Hartley, Tom T.; Lorenzo, Carl F.

Abstract: Our control philosophy is to charge the NiH₂ cell in such a way that the damage incurred during the charging period is minimized, thus extending its cycle life. This requires nonlinear dynamic model of NiH₂ cell and a damage rate model. We must do this first. This control philosophy is generally considered damage mitigating control or life-extending control. This presentation covers how NiH₂ cells function, electrode behavior, an essentialized model, damage mechanisms for NiH₂ batteries, battery continuum damage modeling, and battery life models. The presentation includes graphs and a chart illustrating how charging a NiH₂ battery with different voltages and currents affects damages the battery and affects its life. The presentation concludes with diagrams of control system architectures for tracking battery recharging.

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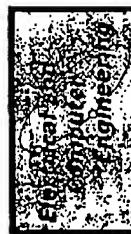
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NASA Official: Calvin E. Mackey
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Optimal Battery Charging for Damage Mitigation

NASA Grant NCC3-820

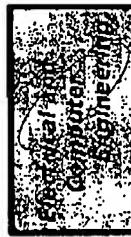
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- For the discussion of the next two sections, consider the electrode process :



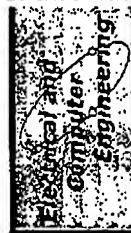
- This equation represents both a chemical process and an electrical process.
- The reaction rates can be completely determined using the electrical process by seeing that the chemical conversion can only occur if electrons are either arriving or leaving.
- Thus, the chemical conversion rates are controlled by, or measured by, the electrical current passing through a given electrode.
- Then recognizing that the rate of electron production is related to electrical current i , the following rate equations result :

$$-i \equiv \frac{dq_{e^-}}{dt} = -\frac{dD}{n dt} = -\frac{c}{n} \frac{dC}{dt} = +\frac{a}{n} \frac{dA}{dt} = +\frac{b}{n} \frac{dB}{dt}$$

where q_{e^-} is the charge of a single electron.



Q5



Terminal behavior:

current into the battery is $+i$,
the terminal voltage is $+v$,

stored material with self-discharge:

$$\frac{dc_s(t)}{dt} = i(t) - 0.0002085c_s(t),$$

diffusing material:

$$c_d(t) = 1 - 0.001036_0 d_t^{-0.9034} i(t),$$

electrode-equation:

$$v = 1.3656 + 0.0265 \ln(1 + |i|) \operatorname{sgn}(i) + 0.0229 \ln(c_d) - 0.0262 \ln((1.005 * 3900 - c_s) / 3900)$$

Qs. 10

